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DIVISION 03 - CONCRETE

SECTION 03101

FORMWORK FOR CONCRETE

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SECTION 03101

FORMWORK FOR CONCRETE

1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 347R (1994) Guide for Formwork for Concrete

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 31 (1994) Making and Curing Concrete Test Specimens in the Field

ASTM C 39 (1993a) Compressive Strength of Cylindrical Concrete Specimens

ASTM C 1074 (1993) Estimating Concrete Strength by the Maturity Method

ASTM C 1077 (1995a) Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation

DEPARTMENT OF COMMERCE (DOC)

DOC PS 1 (1983) Construction and Industrial Plywood

1.2 DESIGN REQUIREMENTS

The design, engineering, and construction of the formwork shall be the responsibility of the Contractor. The formwork shall be designed for anticipated live and dead loads and shall comply with the tolerances specified in Section 03301 CAST-IN-PLACE STRUCTURAL CONCRETE, paragraph CONSTRUCTION TOLERANCES. However, for surfaces with an ACI Class A surface designation, the allowable deflection for facing material between studs, for studs between walers and walers between bracing shall be limited to 0.0025 times the span. The formwork shall be designed as a complete system with consideration given to the effects of cementitious materials and mixture additives such as fly ash, cement type, plasticizers, accelerators, retarders, air entrainment, and others. The adequacy of formwork design and construction shall be monitored prior to and during concrete placement as part of the Contractor's approved Quality Control Plan.

1.3 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-01 Data

Materials; FIO.

Manufacturer's literature shall be submitted for plywood, concrete form hard board, form accessories, prefabricated forms, and form coating.

SD-04 Drawings

Shop Drawings; FIO.

Drawings and design computations for all formwork required shall be submitted at least 30 days either before fabrication on site or before delivery of prefabricated forms.

SD-08 Statements

Shop Drawings; FIO.

If reshoring is permitted, the method, including location, order, and time of erection and removal shall also be submitted for review.

SD-09 Reports

Inspection; FIO.

The Contractor shall submit field inspection reports for concrete forms and embedded items.

Formwork Not Supporting Weight of Concrete; GA.

If forms are to be removed in less than 24 hours on formwork not supporting weight of concrete, the evaluation and results of the control cylinder tests shall be submitted to and approved before the forms are removed.

SD-14 Samples

Sample Panels; GA.

After shop drawings have been reviewed, sample panels for Class A finish shall be built on the project site where directed.

1.4 SHOP DRAWINGS

The shop drawings and data submitted shall include the type, size, quantity, and strength of all materials of which the forms are made, the plan for jointing of facing panels, details affecting the appearance, and the assumed design values and loading conditions.

1.5 SAMPLE PANELS

Panels shall be of sufficient size to contain joints and shall be not less than 6 feet long and 4 feet wide. The panels shall be of typical wall thickness and constructed containing the full allocation of reinforcing steel that will be used in the structure, with the forming system that duplicates in every detail the one that will be used in construction of the structure. The same concrete mixture proportion and materials, the same placement techniques and equipment, and the same finishing techniques and timing shall be used that are planned for the structure. Construction of Class A finish will not be permitted until sample panels have been approved. Sample panels shall be protected from construction operations in a manner to protect approved finish, and are not to be removed until all Class A finish concrete has been accepted.

2 PRODUCTS

2.1 MATERIALS

2.1.1 Forms

Forms and form liners shall be fabricated with facing materials that will produce a finish meeting the specified construction tolerance requirements and the following surface classifications as defined in ACI 347R and as adjusted in Section 03301 CAST-IN-PLACE STRUCTURAL CONCRETE.

2.1.1.1 Class "A" Finish

This class of finish shall apply to all concrete surfaces designed to be exposed to flowing water during the life of the structure. The form facing material shall be composed of new, well-matched tongue-and-groove lumber or new plywood panels conforming to DOC PS 1, Grade B-B concrete form, Class I.

2.1.1.2 Class "B" Finish

This class of finish shall apply to all exposed surfaces except those specified to receive Class A or Class D. The form facing material shall be composed of tongue-and-groove or shiplap lumber, plywood conforming to DOC PS 1, Grade B-B concrete form, tempered concrete form hard board or steel. Steel lining on wood sheathing will not be permitted.

2.1.1.3 Class "D" Finish

This class of finish shall apply to concrete faces against which earth fill will be placed. The form facing may be of wood or steel.

2.1.2 Form Coating

Form coating shall be commercial formulation that will not bond with, stain, cause deterioration, or any other damage to concrete surfaces. The coating shall not impair subsequent treatment of concrete surfaces depending upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds. If special form liners are to be used, the Contractor shall follow the recommendation of the form coating manufacturer.

2.2 ACCESSORIES

Ties and other similar form accessories to be partially or wholly embedded in the concrete shall be of a commercially manufactured type. After the ends or end fasteners have been removed, the embedded portion of metal ties shall terminate not less than 2 inches from any concrete surface either exposed to view or exposed to water. Plastic snap ties may be used in locations where the surface will not be exposed to view. Form ties shall be constructed so that the ends or end fasteners can be removed without spalling the concrete.

3 EXECUTION

3.1 INSTALLATION

3.1.1 Form Construction

Forms shall be constructed true to the structural design and required alignment. The form surface and joints shall be mortar tight and supported to achieve safe performance during construction, concrete placement, and form removal. The Contractor shall continuously monitor the alignment and stability of the forms during all phases to assure the finished product will meet the required surface classes specified in paragraph FORMS and tolerances specified in paragraph DESIGN REQUIREMENTS. Failure of any supporting surface either due to surface texture, deflection or form collapse shall be the responsibility of the Contractor as will the replacement or correction of unsatisfactory surfaces. When forms for continuous surfaces are placed in successive units, care shall be taken to fit the forms over the completed surface to obtain accurate alignment of the surface

and to prevent leakage of mortar. Forms shall not be re-used if there is any evidence of defects which would impair the quality of the resulting concrete surface. All surfaces of used forms shall be cleaned of mortar and any other foreign material before reuse.

3.1.2 Chamfering

All exposed joints, edges and external corners shall be chamfered by molding placed in the forms unless the drawings specifically state that chamfering is to be omitted or as otherwise specified. Chamfered joints shall not be permitted where earth or rockfill is placed in contact with concrete surfaces. Chamfered joints shall be terminated twelve (12) inches outside the limit of the earth or rockfill so that the end of the chamfers will be clearly visible.

3.1.3 Coating

Forms for exposed or painted surfaces shall be coated with form oil or a form-release agent before the form or reinforcement is placed in final position. The coating shall be used as recommended in the manufacturer's instructions. Forms for unexposed surfaces may be wet with water in lieu of coating immediately before placing concrete, except that, in cold weather when freezing temperatures are anticipated, coating shall be mandatory. Surplus coating on form surfaces and coating on reinforcing steel and construction joints shall be removed before placing concrete.

3.2 FORM REMOVAL

Forms shall not be removed without approval. The minimal time required for concrete to reach a strength adequate for removal of formwork without risking the safety of workers or the quality of the concrete depends on a number of factors including, but not limited to, ambient temperature, concrete lift heights, type and amount of concrete admixture, and type and amount of cementitious material in the concrete. It is the responsibility of the Contractor to consider all applicable factors and leave the forms in place until it is safe to remove them. In any case forms shall not be removed unless the minimum compressive strength requirements below are met, except as otherwise directed or specifically authorized. When conditions are such as to justify the requirement, forms will be required to remain in place for a longer period. All removal shall be accomplished in a manner which will prevent damage to the concrete and ensure the complete safety of the structure. Where forms support more than one element, the forms shall not be removed until the form removal criteria are met by all supported elements. Form removal shall be scheduled so that all necessary repairs can be performed as specified in Section 03301 CAST-IN-PLACE STRUCTURAL CONCRETE, paragraph FORMED SURFACES. Evidence that concrete has gained sufficient strength to permit removal of forms shall be determined by tests on control cylinders. All control cylinders shall be stored in the structure or as near the structure as possible so they receive the same curing conditions and protection methods as given those portions of the structure they represent. Control cylinders shall be removed from the molds at an age of no more than 24 hours. All control cylinders shall be prepared and tested in accordance with ASTM C 31 and ASTM C 39 at the expense of the Contractor by an independent laboratory that complies with ASTM C 1077 and shall be tested within 4 hours after removal from the site.

3.2.1 Formwork Not Supporting Weight of Concrete

Formwork for walls, columns, sides of beams, gravity structures, and other vertical type formwork not supporting the weight of concrete shall not be removed in less than 24 hours after concrete placement is completed.

3.2.2 Formwork Supporting Weight of Concrete

Formwork supporting weight of concrete and shoring shall not be removed until structural members have acquired sufficient strength to safely support their own weight and any construction or other superimposed loads to which the supported concrete may be subjected. As a minimum, forms shall be left in place until control concrete test cylinders indicate evidence the concrete has attained at least 70 percent of the compressive strength required for the structure in accordance with the quality and location requirements of 03301 CAST-IN-PLACE STRUCTURAL CONCRETE, paragraph REQUIRED AVERAGE COMPRESSIVE STRENGTH.

3.3 INSPECTION

Forms and embedded items shall be inspected in sufficient time prior to each concrete placement by the Contractor in order to certify to the Contracting Officer that they are ready to receive concrete. The results of each inspection shall be reported in writing.

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SECTION 03150

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SECTION 03150

EXPANSION, CONTRACTION AND CONSTRUCTION JOINTS IN CONCRETE

1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1751	(1983; R 1991) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
ASTM D 1752	(1984; R 1992) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 2628	(1991) Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
ASTM D 2835	(1989) Lubricant for Installation of Preformed Compression Seals in Concrete Pavements

FEDERAL SPECIFICATIONS (FS)

FS TT-S-00227	(Rev E; Am 3) Sealing Compound: Elastomeric Type, Multi-Component (for Caulking, Sealing, and Glazing in Buildings and Other Structures)
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1.2 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-09 Reports

Premolded Expansion Joint Filler Strips; GA. Compression Seals and Lubricant; GA.

Premolded expansion joint filler strips, compression seals and lubricant will be accepted on the basis of the manufacturer's certification of compliance accompanied by test reports that materials meet the requirements of the specification under which they are furnished. No materials shall be used until notice of acceptance has been given by the Contracting Officer. Certified copies of the manufacturer's test reports shall be submitted not less than 30 days before the materials are required in the work. Test reports of more than 6 months olds shall be rejected and that the materials shall be retested in conformance with paragraph MATERIALS TESTS.

2 PRODUCTS

2.1 MATERIALS

2.1.1 Premolded Expansion Joint Filler Strips

Premolded expansion joint filler strips shall conform to ASTM D 1751 or ASTM D 1752, Type I, or resin impregnated fiberboard conforming to the physical requirements of ASTM D 1752.

2.1.2 Joint Seals and Sealants

2.1.2.1 Field Molded Sealants and Primer

Field molded sealants shall conform to FS TT-S-00227, Type II for vertical joints and Type I for horizontal joints, Class A. Bond breaker material shall be polyethylene tape, coated paper, metal foil or similar type materials. The back-up material shall be compressible, non-shrink, non-reactive with sealant, and non-absorptive material type such as extruded butyl or polychloroprene foam rubber.

2.1.2.2 Compression Seals and Lubricant

Compression seals shall conform to ASTM D 2628; lubricant for installation shall conform to ASTM D 2835.

2.2 MATERIALS TESTS

2.2.1 Field-Molded Sealants

Samples of sealant and primer, when use of primer is recommended by the manufacturer, as required in paragraph FIELD MOLDED SEALANT AND PRIMER shall be tested by and at the expense of the Contractor for compliance with FS TT-S-00227. If the sample fails to meet specification requirements, new samples shall be tested and the cost of retesting will be borne by the Contractor.

3 EXECUTION

3.1 INSTALLATION

Joint locations and details, including materials and methods of installation of joint fillers, shall be as specified, as shown, and as directed. In no case shall any fixed metal be continuous through an expansion or contraction joint. Concrete shall be fully cured (28 days) prior to the installation of joint sealant.

3.1.1 Expansion Joints

Premolded filler strips shall have oiled wood strips secured to the top thereof and shall be accurately positioned and secured against displacement to clean, smooth concrete surfaces. The wood strips shall be slightly tapered, dressed and of the size required to install filler strips at the desired level below the finished concrete surface and to form the groove for the joint sealant or seals to the size shown. Material used to secure premolded fillers and wood strips to concrete shall not harm the concrete and shall be compatible with the joint sealant or seals. The wood strips shall not be removed until after the concrete curing period. The groove shall be thoroughly cleaned of all laitance, curing compound, foreign materials, protrusions of hardened concrete and any dust which shall be blown out of the groove with oil-free compressed air.

3.1.1.1 Joints With Field-Molded Sealant

Joints shall not be sealed when the sealant, air or concrete temperature is less than 40 degrees F. Bond breaker and back-up material shall be installed where required. Joints shall be primed and filled flush with joint sealant in accordance with the manufacturer's recommendations.

3.1.1.2 Joints With Preformed Compression Seals

The joint seals shall be installed with equipment which shall be capable of installing joint seals to the prescribed depth without cutting, nicking, twisting, or otherwise distorting or damaging the seal and with no more than five percent stretching of the seal. The sides of the joint and, if necessary, the sides of the compression seal shall be covered with a coating of lubricant, and the seal shall be installed to the depth indicated with joint installation equipment. Butt joints shall be coated with liberal applications of lubricant.

3.1.2 Contraction Joints

Joints requiring a bond breaker shall be coated with curing compound or with bituminous paint.

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SECTION 03210

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SECTION 03210

STEEL BARS FOR CONCRETE REINFORCEMENT

1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 315 (1980; R 1986) ACI Detailing Manual: Section Details and Detailing of Concrete Reinforcement

ACI 318/318R (1995) Building Code Requirements for Reinforced Concrete

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 370 (1994) Mechanical Testing of Steel Products

ASTM A 615/A 615M (1993) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

ASTM A 706/A 706M (1993a) Low-Alloy Steel Deformed Bars for Concrete Reinforcement

ASTM A 775/A 775M (1993a) Epoxy-Coated Reinforcing Steel Bars

1.2 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

SD-04 Drawings

Fabrication and Placement; GA.

The Contractor shall submit shop drawings which include reinforcement steel placement drawings; reinforcement steel schedules showing quantity, size, shape, dimensions, weight per foot, total weights and bending details; and details of bar supports showing types, sizes, spacing and sequence.

SD-09 Reports

Materials; GA. Tests, Inspections, and Verifications; GA.

Certified tests reports of reinforcement steel showing that the steel complies with the applicable specifications shall be furnished for each steel shipment and identified with specific lots prior to placement. Three copies of the heat analyses shall be provided for each lot of steel furnished and the Contractor shall certify that the steel conforms to the heat analyses.

SD-13 Certificates

Epoxy-Coated Bars; FIO.

Written certification for coating material and coated bars shall be submitted with the delivery of the bars.

SD-14 Samples

Epoxy-Coated Bars; FIO.

Sample of coating material and 1.5 pounds of patching material shall be submitted with the delivery of the bars.

SD-18 Records

Materials; GA.

A system of identification which shows the disposition of specific lots of approved materials in the work shall be established and submitted before completion of the contract.

2 PRODUCTS

2.1 MATERIALS

2.1.1 Steel Bars

Steel bars shall comply with the requirements of ASTM A 615/A 615M, ASTM A 706/A 706M, deformed, of the grade 60 bars. Yield strength (f_y) exceeding 60,000 psi, shall be the stress corresponding to a strain of 0.35 percent.

2.1.1.1 Epoxy-Coated Bars

Epoxy-coated steel bars shall comply with the requirements of ASTM A 775/A 775M.

2.1.2 Accessories

2.1.2.1 Bar Supports

Bar supports shall comply with the requirements of ACI 315. Supports for bars in concrete with formed surfaces exposed to view or to be painted shall be plastic-coated wire, stainless steel or precast concrete supports. Precast concrete supports shall be wedged-shaped, not larger than 3-1/2 by 3-1/2 inches, of thickness equal to that indicated for concrete cover and have an embedded hooked tie-wire for anchorage. Bar supports used in precast concrete with formed surfaces exposed to view shall be the same quality, texture and color as the finish surfaces.

2.1.2.2 Wire Ties

Wire ties shall be 16 gage or heavier black annealed wire. Ties for epoxy-coated bars shall be vinyl-coated or epoxy-coated.

2.2 TESTS, INSPECTIONS, AND VERIFICATIONS

The Contractor shall have material tests required by applicable standards and specified herein performed by an approved laboratory and certified to demonstrate that the materials are in conformance with the specifications. Tests shall be performed and certified at the Contractor's expense.

2.2.1 Reinforcement Steel Tests

Mechanical testing of steel shall be in accordance with ASTM A 370 except as otherwise specified or required by the material specifications. Tension tests shall be performed on full cross-section specimens using a gage length that spans the extremities of specimens with welds or sleeves included. Chemical analyses of steel heats shall show the percentages of carbon, phosphorous, manganese, sulphur and silicon present in the steel.

2.2.2 (DELETED)

2.2.3 (DELETED)

2.2.4 (DELETED)

3 EXECUTION

3.1 FABRICATION AND PLACEMENT

Reinforcement steel and accessories shall be fabricated and placed as specified and shown and approved shop drawings. Fabrication and placement details of steel and accessories not specified or shown shall be in accordance with ACI 315 and ACI 318/318R also or as directed. Steel shall be fabricated to shapes and dimensions shown, placed where indicated within specified tolerances and adequately supported during concrete placement. At the time of concrete placement all steel shall be free from loose, flaky rust, scale (except tight mill scale), mud, oil, grease or any other coating that might reduce the bond with the concrete.

3.1.1 Hooks and Bends

Steel bars, except epoxy-coated, shall be mill or field-bent. Epoxy-coated bars shall be mill-bent prior to coating. All steel shall be bent cold unless authorized. No steel bars shall be bent after being partially embedded in concrete unless indicated or authorized.

3.1.2 (DELETED)

3.1.3 Placing Tolerances

3.1.3.1 Spacing

The spacing between adjacent bars and the distance between layers of bars may not vary from the indicated position by more than one bar diameter nor more than 1 inch.

3.1.3.2 Concrete Cover

The minimum concrete cover of main reinforcement steel bars shall be as shown. The allowable variation for minimum cover shall be as follows:

MINIMUM COVER	VARIATION
6 inch	plus 1/2 inch
4 inch	plus 3/8 inch
3 inch	plus 3/8 inch
2 inch	plus 1/4 inch
1-1/2 inch	plus 1/4 inch
1 inch	plus 1/8 inch
3/4 inch	plus 1/8 inch

3.1.4 Splicing

Splices in steel bars shall be made only as required. Bars may be spliced at alternate or additional locations at no additional cost to the Government subject to approval.

3.1.4.1 Lap Splices

Lap splices shall be used only for bars small than size 14 and welded wire fabric. Lapped bars may be placed in contact and securely tied or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete. Lapped bars shall not be spaced farther apart than 1/5 the required length of lap or 6 inches.

3.2 (DELETED)

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SECTION 03301

CAST-IN-PLACE STRUCTURAL CONCRETE

PART 1 GENERAL

1.1 RELATED WORK SPECIFIED ELSEWHERE

1.1.1 Expansion, Contraction and Construction Joints in Concrete

SECTION: EXPANSION, CONTRACTION AND CONSTRUCTION JOINTS IN CONCRETE.

1.1.2 Steel Bars for Concrete Reinforcement

SECTION: CONCRETE REINFORCEMENT.

1.1.3 Formwork for Concrete

SECTION: FORMWORK FOR CONCRETE.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.1 (1991) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete

ACI 305R (1991) Hot Weather Concreting

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 31 (1991) Making and Curing Concrete Test Specimens in the Field

ASTM C 33 (1993) Concrete Aggregates

ASTM C 39 (1994) Compressive Strength of Cylindrical Concrete Specimens

ASTM C 42 (1994) Obtaining and Testing Drilled Cores and Sawed Beams in Concrete

ASTM C 70 (1979; R 1985) Surface Moisture in Fine Aggregate

ASTM C 94 (1994) Ready-Mixed Concrete

ASTM C 136 (1995a) Sieve Analysis of Fine and Coarse Aggregates

ASTM C 143 (1990a) Slump of Hydraulic Cement Concrete

ASTM C 150 (1995) Portland Cement

ASTM C 171 (1992) Sheet Materials for Curing Concrete

ASTM C 172 (1990) Sampling Freshly Mixed Concrete

ASTM C 192 (1990a) Making and Curing Concrete Test Specimens in the Laboratory

ASTM C 231	(1991b) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(1986) Air-Entraining Admixtures for Concrete
ASTM C 309	(1991) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 494	(1992) Chemical Admixtures for Concrete
ASTM C 566	(1989) Total Moisture Content of Aggregate by Drying
ASTM C 597	(1983; R 1991) Pulse Velocity Through Concrete
ASTM C 618	(1994a) Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C 803	(1990) Penetration Resistance of Hardened Concrete
ASTM C 805	(1994) Rebound Number of Hardened Concrete
ASTM C 881	(1990) Epoxy-Resin Base Bonding Systems for Concrete
ASTM C 1077	(1995a) Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C 1107	(1991a) Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM D 75	(1987; R 1992) Sampling Aggregates

CORPS OF ENGINEERS (COE)

COE CRD-C 94	(1995) Specifications for Surface Retarders
COE CRD-C 100	(1975) Method of Sampling Concrete Aggregate and Aggregate Sources and Selection of Material for Testing
COE CRD-C 104	(1980) Method of Calculation of Fineness Modulus of Aggregate
COE CRD-C 112	(1969) Surface Moisture in Aggregate by Water Displacement
COE CRD-C 143	(1962) Meters for Automatic Indication of Moisture in Fine Aggregate
COE CRD-C 318	(1972) Cloth, Burlap, Jute (or Kenaf)
COE CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete
COE CRD-C 521	(1981) Standard Test Method for Frequency and Amplitude of Vibrators for Concrete
COE CRD-C 621	(1989) Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

NATIONAL READY-MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA CPMB	(1990) Concrete Plant Standards
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NATIONAL BUREAU OF STANDARDS (NBS) HANDBOOK

NIST HB 44 (1994) NIST Handbook 44: Specifications, Tolerances, and Other Technical Requirements for Commercial Weighing and Measuring Devices

1.3 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES.

SD-01 Data

Concrete Mixture Proportioning; FIO.

Concrete mixture proportions shall be determined by the Contractor, in accordance with the requirements in paragraph CONCRETE MIXTURE PROPORTIONING, and submitted for review. The concrete mixture quantities of all ingredients per cubic meter and nominal maximum coarse aggregate size that will be used in the manufacture of each quality of concrete shall be stated. Proportions shall indicate the mass of cement and pozzolan when used and water; the mass of aggregates in a saturated surfacedry condition; and the quantities of admixtures. The submission shall be accompanied by test reports from a laboratory complying with ASTM C 1077 which show that proportions thus selected will produce concrete of the qualities indicated. No substitution shall be made in the source or type of materials used in the work without additional tests to show that the quality of the new materials and concrete are satisfactory.

Concrete Mixers; FIO.

The Contractor shall submit concrete mixer data which includes the make, type, and capacity of concrete mixers proposed for mixing concrete in conformance with the paragraph MIXERS.

Conveying Equipment and Methods; FIO.

The conveying equipment and methods for transporting, handling, and depositing the concrete shall be submitted for review by the Contracting Officer for conformance with paragraphs CONVEYING EQUIPMENT.

Placing Equipment and Methods; FIO.

All placing equipment and methods shall be submitted for review by the Contracting Officer for conformance with paragraph PLACING.

SD-08 Statements

Testing Technicians; FIO. Concrete Construction Inspector; FIO.

The Contractor shall submit statements that the concrete testing technicians and the concrete inspectors meet the requirements of paragraph CONTRACTOR QUALITY CONTROL.

Construction Joint Treatment; GA.

The method and equipment proposed for joint cleanup and waste disposal shall be submitted for review and approval for conformance with paragraph CONSTRUCTION JOINT TREATMENT.

Curing and Protection; GA.

The curing medium and methods to be used shall be submitted for review and approval for conformance with paragraph CURING AND PROTECTION.

Cold-Weather Placing; GA.

If concrete is to be placed under cold-weather conditions, the proposed materials, methods, and protection meeting the requirements of paragraph COLDWEATHER PLACING shall be submitted for approval.

Hot-Weather Placing; GA.

If concrete is to be placed under hot-weather conditions, the proposed materials and methods, meeting the requirements of paragraph HOTWEATHER PLACING and paragraph FINISHING, shall be submitted for review and approval.

SD-09 Reports

Uniformity of Concrete Mixing; FIO.

The results of the initial mixer uniformity tests as required in paragraph MIXER UNIFORMITY shall be submitted at least 5 days prior to the initiation of placing.

Tests and Inspections; FIO.

Test results and inspection reports shall be submitted daily and weekly as required in paragraph REPORTS.

SD-13 Certificates

Cementitious Materials; FIO.

Cementitious Materials, including Cement and Pozzolan, will be accepted on the basis of the manufacturer's certification of compliance, accompanied by mill test reports that materials meet the requirements of the specification under which they are furnished. Certification and mill test reports shall be from samples taken from the particular lot furnished. No cementitious materials shall be used until notice of acceptance has been given by the Contracting Officer. Cementitious materials will be subject to check testing from samples obtained at the source, at transfer points, or at the project site, as scheduled by the Contracting Officer, and such sampling will be by or under the supervision of the Government at its expense. Material not meeting specifications shall be promptly removed from the site of work.

Other Chemical Admixtures; FIO.

Other Chemical Admixtures shall be certified for compliance with all specification requirements.

Membrane-Forming Curing Compound; FIO.

Membrane-Forming Curing Compound shall be certified for compliance with all specification requirements.

Epoxy Resin; FIO.

Epoxy Resin shall be certified for compliance with all specification requirements.

Nonshrink Grout; FIO.

Descriptive literature of the nonshrink grout proposed for use shall be furnished together with a certificate from the manufacturer stating that it is suitable for the application for which it is being considered.

1.4 QUALITY ASSURANCE

1.4.1 Aggregate Sources

1.4.1.1 Concrete aggregates may be selected from the following existing commercial sources:

- a. Nevada Ready MixLone Mountain Pit
- b. WMK MaterialBuffalo Road Pit
- c. Bonanza MaterialsHenderson
- d. American Sands and GravelNellis AFB Vicinity
- e. Lopke GraniteHenderson

1.4.1.2 At the option of the Contractor concrete aggregates may be furnished from any source designated by the Contractor and approved by the Contracting Officer, subject to the conditions hereinafter stated.

1.4.1.3 After the award of the contract, the Contractor shall designate in writing only one source or one combination of sources from which he proposes to furnish aggregates. If the Contractor proposes to furnish aggregates from a source or from sources not listed above, he may designate only a single source or single combination of sources for aggregates. Samples for acceptance testing shall be provided as specified herein. If a source for coarse or fine aggregate so designated by the Contractor is not approved for use by the Contracting Officer, the Contractor may not submit for approval other sources but shall furnish the coarse or fine aggregate, as the case may be, from an approved source listed above at no additional cost to the Government. Listing of a concrete aggregate source is not to be construed as approval of all materials from the source. The right is reserved to reject materials from certain localized areas, zones, strata, or channels, when such materials are unsuitable for concrete aggregate as determined by the Contracting Officer. Materials produced from an approved source shall meet all the requirements specified herein.

1.4.2 Preconstruction Sampling and Testing

1.4.2.1 Aggregates

The aggregate sources listed above have in the past been determined to be capable of producing materials of a quality acceptable for this project. The Contractor shall provide samples of aggregates from proposed sources listed and not listed in above. Aggregate samples shall consist of not less than 1,000 pounds of each size coarse aggregate and 1,000 pounds of fine aggregate, taken under the supervision of the Contracting Officer in accordance with COE CRD-C-100. Samples shall be delivered to a local materials testing laboratory selected by the Government.

Samples shall be delivered to the lab within 15 days after Notice to Proceed. All sampling and shipment of samples shall be at the Contractor's expense. A maximum of 45 days after receipt of the samples will be required to complete evaluation of aggregates from sources listed herein. A maximum of 60 days after receipt of the samples will be required to complete evaluation of aggregates from sources not listed herein. Testing will be performed by and at the expense of the Government in accordance with the applicable COE CRD-C or ASTM test method. The cost of testing one source for each size of aggregate will be borne by the Government. If the Contractor selects more than one source for each aggregate size or selects a substitute source for any size aggregate after the original source was tested, the cost of that additional testing will be borne by the Contractor. If the source selected by the Contractor fails to supply materials that are at least equivalent to the sources listed as determined by the Government, the Contractor will be required to propose a new source or elect a source listed above to supply aggregates. Tests to which aggregate may be subjected are specific gravity, absorption, L.A. abrasion, alkali-aggregate reaction, organic impurities, and any other test necessary to demonstrate that the aggregate is of a quality that is at least equivalent to those sources listed herein. The Government reserves the right to reject materials found

to be unsuitable when produced from any source, even a source that is listed herein.

Testing of aggregates by the Government does not relieve the Contractor of the requirements outlined in paragraph CONTRACTOR QUALITY CONTROL.

1.4.3 Cementitious Materials, Admixtures, and Curing Compound

At least 60 days in advance of concrete placement, the Contractor shall notify the Contracting Officer of the source of cementitious materials, admixtures, and curing compound, along with sampling location, brand name, type, and quantity to be used in the manufacture of the concrete. If cement or pozzolan is to be obtained from more than one source, the initial notification shall state the estimated amount to be obtained from each source and the proposed schedule of shipments. No material shall be used until notice has been given by the Contracting Officer that test results are satisfactory, and all movement of materials after sampling shall be as directed.

1.4.4 Chemical Admixtures Storage

Chemical admixtures that have been in storage at the project site for longer than 6 months or that have been subjected to freezing shall be tested at the expense of the Contractor when directed by the Contracting Officer and shall be rejected if test results are not satisfactory. Chemical admixtures will be accepted based on compliance with the requirements of paragraph ADMIXTURES.

1.4.5 Construction Testing by Government

The Government will sample and test aggregates and concrete to determine compliance with the specifications. The Contractor shall provide facilities and labor as may be necessary for procurement of representative test samples. Samples of aggregates will be obtained at the point of batching in accordance with ASTM D 75. Concrete will be sampled in accordance with ASTM C 172. Slump and air content will be determined in accordance with ASTM C 143 and ASTM C 231, respectively. Compression test specimens will be made and laboratory cured in accordance with ASTM C 31, and compression test specimens tested in accordance with ASTM C 39.

1.5 EVALUATION AND ACCEPTANCE

1.5.1 Concrete Strength

The strength of the concrete will be considered satisfactory so long as the average of all sets of three consecutive test results equals or exceeds the required specified compressive strength f'_c and no individual test (average of two cylinders) result falls below the specified compressive strength f'_c by more than 500 pounds per square inch. Additional analysis or testing may be required at the Contractor's expense when the strength of the concrete in the structure is considered potentially deficient.

1.5.1.1 Investigation of Low-Strength Test Results

When any strength test of standard-cured test cylinders falls below the specified strength requirement by more than 500 pounds per square inch or if tests of field-cured cylinders indicate deficiencies in protection and curing, steps shall be taken to assure that the load-carrying capacity of the structure is not jeopardized. Nondestructive testing in accordance with ASTM C 597, C 803, or C 805 may be permitted by the Contracting Officer to determine the relative strengths at various locations in the structure as an aid in evaluating concrete strength in place or for selecting areas to be cored. Such tests, unless properly calibrated and correlated with other test data, shall not be used as a basis for acceptance or rejection.

1.5.1.2 Testing of Cores

When the strength of concrete in place is considered potentially deficient, cores shall be obtained and tested in accordance with ASTM C 42. At least three representative cores shall be taken from each member or area of concrete in place

that is considered potentially deficient. The location of cores will be determined by the Contracting Officer to least impair the strength of the structure. If the concrete in the structure will be dry under service conditions, the cores shall be air dried (temperature 60 to 80 degrees F, relative humidity less than 60 percent) for 7 days before testing and shall be tested dry. If the concrete in the structure will be more than superficially wet under service conditions, the cores shall be tested after moisture conditioning in accordance with ASTM C 42. Concrete in the area represented by the core testing will be considered adequate if the average strength of the cores is equal to at least 85 percent of the specified strength requirement and if no single core is less than 75 percent of the specified strength requirement.

1.5.2 Construction Tolerances

Variation in alignment, grade, and dimensions of the structures from the established alignment, grade, and dimensions shown on the drawings shall be within the tolerances specified in the following table:

ALL STRUCTURES EXPOSED TO FLOW

- | | | |
|-----|--|---|
| (1) | Departure from established alignment or from established grade | 1/2 inch |
| (2) | Variation in thickness at any point | minus 2-1/2 percent or 1/4 inch, whichever is greater |
| | | plus 5 percent or 1/2 inch, whichever is greater |
| (3) | Variation from inside dimension..... | 1/2 of 1 percent |
| (4) | Departure from established alignment on tangent | 2 inches |
| | on curve | 4 inches |
| (5) | Departure from established profile grade | 1 inch |
| (6) | Reduction in thickness in lining | 10 percent of specified thickness: provided that average thickness is maintained as determined by daily batch volumes |
| (7) | Variation from specified width of section at any height | 1/4 of 1 percent plus 1 inch |
| (8) | Variations in surfaces | |
| | Invert | 1/8 inch in 3 feet |
| | Side slopes | 1/8 inch in 3 feet |
| (9) | Abrupt Variation | |

The offset between concrete surfaces for the following classes of surface:

Class A	1/8 inch
---------------	----------

Class B 1/4 inch
Class D 1 inch

(10) Gradual Variation

Surface finish tolerances as measured by placing a free standing unlevelled), 1.5 m straightedge for plane surface or curved template for curved surface any where on the surface and allowing it to rest upon two high spots within 72 hr after concrete placement. The gap at any point between the straight edge or template and the surface shall not exceed:

Class A 1/8 inch
Class B 1/4 inch
Class D 1 inch

(11) Footings:

a. Variation of dimensions in plan

Minus..... ? inch
 Plus..... 2 inches when formed
 or plus 3 inches when
 placed against unformed
 excavation.

b. Misplacement of eccentricity 2 percent of the
 footing width in the
 direction of
 misplacement but not
 more than 2 inches

c. Reduction in thickness Minus..... 5 percent of specified
 thickness

1.5.3 Appearance

Permanently exposed surfaces shall be cleaned, if stained or otherwise discolored, by a method that does not harm the concrete and that is approved by the Contracting Officer.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Cementitious Materials

Cementitious materials shall be Portland cement or Portland cement in combination with pozzolan and shall conform to appropriate specifications listed below.

2.1.1.1 Portland Cement

ASTM C 150, Type V, high sulfate resistant cement.

2.1.1.2 Pozzolan

Pozzolan shall conform to ASTM C 618, Class F, with loss on ignition limited to 6 percent.

2.1.2 Aggregates

Aggregates shall be produced from the sources listed and under the conditions described in paragraph: Quality Assurance, subparagraph Aggregate Sources. Fine and coarse aggregates shall conform to the grading requirements of ASTM C 33. The nominal maximum size shall be as listed in paragraph: Nominal Maximum-Size Coarse

Aggregate. The proposed gradations to be used shall be submitted to the Contracting Officer for approval.

2.1.3 Admixtures

Admixtures to be used, when required or permitted, shall conform to the appropriate specification listed below:

2.1.3.1 Air-Entraining Admixture

ASTM C 260. The air-entraining admixture shall consistently cause the concrete to have an air content in the specified ranges under field conditions.

2.1.3.2 Water-Reducing or Retarding Admixtures

ASTM C 494, Type A, B, or D.

2.1.4 Curing Materials

2.1.4.1 Impervious-Sheet Materials

ASTM C 171, type optional, except polyethylene film, if used, shall be white opaque.

2.1.4.2 Membrane-Forming Curing Compound

ASTM C 309, Type 2.

2.1.5 Epoxy Resin

All epoxy resin materials shall be two component materials conforming to the requirement of ASTM C 881, Class C.

2.1.5.1 The materials for bonding freshly mixed Portland cement concrete or mortar or freshly mixed epoxy resin concrete to hardened concrete shall be Type II materials, Grade 2.

2.1.5.2 The epoxy resin materials use as patching materials for complete filling of spalls, wide cracks, and other voids; for embedding dowels and anchor bolts with concrete shall be Type III materials, Grade 3.

2.1.6 Water

Water for mixing and curing shall be fresh, clean, drinkable, and free of injurious amounts of oil, acid, salt, or alkali, except that undrinkable water may be used if it meets the requirements of COE CRD-C 400.

2.1.7 Nonshrink Grout

Nonshrink grout shall conform to ASTM C 1107 and shall be commercial formulation suitable for the application proposed.

2.2 CONCRETE MIXTURE PROPORTIONING

2.2.1 Quality and Location

For each portion of the structure, mixture proportions shall be selected so that the following strength and water-cement ratio requirements are met.

2.2.1.1 Strength

Specified compressive strength f'_c shall be as follows:

Compressive Strength

Structure or Portion of Structure
SECTION 03301 PAGE 9

3,000 @ 28 days
4,000 @ 28 days21

Cast-In-Place Structures not otherwise specified.
Cast-In-Place Box Culverts and side drain outlet
structures.

2.2.1.2 Maximum Water-Cement Ratio

Maximum water-cement ratio shall be 0.45 for all concrete structures.

2.2.2 Nominal Maximum-Size Coarse Aggregate

Nominal maximum-size coarse aggregate shall be 1-1/2 inches except 3/4-inch nominal maximum-size coarse aggregate shall be used when any of the following conditions exist: the narrowest dimension between sides of forms is less than 71/2 inches, the depth of the slab is less than 4-1/2 inches, or the minimum clear spacing between reinforcing is less than 2 inches.

2.2.3 Air Content

Air content as determined by ASTM C 231 shall be between 4 and 6 percent.

2.2.4 Slump

The slump shall be determined in accordance with ASTM C 143 and shall be within the range of 1 to 3 inches. Where placement by pump is approved, the slump shall not exceed 5 inches.

2.2.5 Concrete Proportioning

Trial design batches and testing requirements for various qualities of concrete specified shall be the responsibility of the Contractor. Samples of approved aggregates shall be obtained in accordance with the requirements of ASTM D 75. Samples of materials other than aggregate shall be representative of those proposed for the project and shall be accompanied by the manufacturer's test reports indicating compliance with applicable specified requirements. Trial mixtures having proportions, consistencies, and air content suitable for the work shall be made based on methodology described in ACI 211.1, using at least three different water-cement ratios, which will produce a range of strength encompassing those required for the work. The water-cement ratios required in paragraph: Maximum Water-Cement Ratio, will be converted to a weight ratio of water to cement plus pozzolan by weight equivalency as described in ACI 211.1. Trial mixtures shall be designed for maximum permitted slump and air content. The temperature of concrete in each trial batch shall be reported. For each maximum aggregate size selected at each water-cement ratio, at least three test cylinders for each test age shall be made and cured in accordance with ASTM C 192. They shall be tested at 7 and 28 days in accordance with ASTM C 39. From these test results, a curve will be plotted showing the relationship between water-cement ratio and strength.

2.2.6 Average Strength

In meeting the water-cement ratio and strength requirements specified in paragraph: Strength above, the selected mixture proportion shall produce an average compressive strength (f_{cr}) exceeding the specified compressive strength f'_c by the amount indicated below with a water-cement ratio at or below that specified above. Where a concrete production facility has test records, a standard deviation shall be established. Test records from which a standard deviation is calculated shall represent materials, quality control procedures, and conditions similar to those expected, shall represent concrete produced to meet a specified strength or strengths (f'_c) within 1,000 pounds per square inch of that specified for proposed work, and shall consist of at least 30 consecutive tests. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days or at another test age designated for determination of f'_c .

2.2.6.1 Required Average Compressive Strength

Required average compressive strength f_{cr} used as the basis for selection of concrete proportions shall be the larger of the equations that follow using the standard deviation as determined above:

$$f_{cr} = f'_c + 1.34S \text{ where } S = \text{standard deviation}$$

$$f_{cr} = f'_c + 2.33S - 500$$

2.2.6.2 Modification Factor for Standard Deviation

Where a concrete production facility does not have test records meeting the requirements above but does have a record based on 15 to 29 consecutive tests, a standard deviation may be established as the product of the calculated standard deviation and a modification factor from the following table:

<u>No. of Tests*</u>	<u>Modification Factor for Standard Deviation</u>
less than 15	Use paragraph 2.2.6.3 hereinafter
15	1.16
20	1.08
25	1.03
30 or more	1.00

* Interpolate for intermediate numbers of tests.

2.2.6.3 Determining Required Average Strength

When a concrete production facility does not have field strength test records for calculation of the standard deviation, the required average strength f_r shall be determined as follows:

If the specified compressive strength f'_c is 3,000 to 5,000 psi, $f_{cr} = f'_c + 1,200$.

2.3 PRODUCTION EQUIPMENT

2.3.1 Batching Plant

Batching plant shall conform to the requirements of the CRD-C-95. Concrete Plant Standards of CPMB and as specified; however, rating plates attached to batch plant equipment are not required.

2.3.1.1 Equipment

The batching controls shall be semiautomatic or automatic. The semiautomatic batching system shall be provided with interlocks such that the discharge device cannot be actuated until the indicated material is within the applicable tolerance. The batching system shall be equipped with an accurate recorder or recorders that meet the requirement of the Concrete Plant Standards of CPMB. Separate bins or compartments shall be provided for each size group of aggregate cement and pozzolan. Aggregates shall be weighed either in separate weigh batchers with individual scales or cumulatively in one weigh batcher on one scale. Aggregate shall not be weighed in the same batcher with cement and pozzolan. If both cement and pozzolan are used, they may be batched cumulatively provided that the Portland cement is batched first. If measured by weight, water shall not be weighed cumulatively with another ingredient. Water batcher filling and discharging valves shall be so interlocked that the discharge valve cannot be opened before the filling valve is fully closed. An accurate mechanical device for measuring and dispensing each admixture shall be provided. Each dispenser shall be interlocked with the batching and discharging operation of the water so that each admixture is separately batched and discharged automatically in a manner to obtain uniform distribution throughout the batch in the specified mixing period. Admixtures shall not be combined prior to introduction of

water or sand. The plant shall be arranged so as to facilitate the inspection of all operations at all times. Suitable facilities shall be provided for obtaining representative samples of aggregates from each bin or compartment.

2.3.1.2 Scales

The weighing equipment shall conform to the applicable requirements of NBS Handbook 44, except that the accuracy shall be plus or minus 0.2 percent of scale capacity. The Contractor shall provide standard test weights and any other auxiliary equipment required for checking the operating performance of each scale or other measuring devices. The tests shall be made at the frequency required in paragraph: Scales, and in the presence of a Government inspector.

2.3.1.3 Batching Tolerances

2.3.1.3.1 Weighing Tolerances

Whichever of the following tolerances is greater shall apply, based on required scale reading.

<u>Material</u>	<u>Percent of Required Weight</u>	<u>Percent of Scale Capacity</u>
Cementitious materials	<u>+1</u>	<u>+0.3</u>
Aggregate	<u>+2</u>	<u>+0.3</u>
Water	<u>+1</u>	<u>+0.3</u>
Admixture	<u>+3</u>	<u>+0.3</u>

2.3.1.3.2 Volumetric Tolerances

For volumetric batching equipment, the following tolerances shall apply to the required volume of material being batched:

Water: Plus or minus 1 percent
Admixtures: Plus or minus 3 percent

2.3.1.4 Moisture Control

The plant shall be capable of ready adjustment to compensate for the varying moisture content of the aggregates and to change the weights of the materials being batched. An electric moisture meter complying with the provisions of COE CRBC 143 shall be provided for measuring moisture in the fine aggregate. The sensing element shall be arranged so that the measurement is made near the batcher charging gate of the sand bin or in the sand batcher.

2.3.2 Mixers

2.3.2.1 General

The mixers shall not be charged in excess of the capacity recommended by the manufacturer. The mixers shall be operated at the drum or mixing blade speed designated by the manufacturer. The mixers shall be maintained in satisfactory operating condition, and the mixer drums shall be kept free of hardened concrete. Should any mixer at any time produce unsatisfactory results, its use shall be promptly discontinued until it is repaired.

2.3.2.2 Concrete Plant Mixers

Concrete plant mixers shall be tilting, nontilting, horizontal-shaft, vertical-shaft type, or pug mill type and shall be provided with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. The mixing time and

uniformity shall conform to all the paragraphs in ASTM C 94 applicable to central-mixed concrete.

2.3.2.3 Truck Mixers

Truck mixers, the mixing of concrete therein, and concrete uniformity shall conform to the requirements of ASTM C 94. A truck mixer may be used either for complete mixing (transit-mixed) or to finish the partial mixing done in a stationary mixer (shrink-mixed). Each truck shall be equipped with two counters from which it will be possible to determine the number of revolutions at mixing speed and the number of revolutions at agitating speed.

2.4 CONVEYING EQUIPMENT

2.4.1 General

Concrete shall be conveyed from mixer to forms as rapidly as practicable and within the time interval in paragraph: Time Interval Between Mixing and Placing by methods that will prevent segregation or loss of ingredients. Any concrete transferred from one conveying device to another shall be passed through a hopper that is conical in shape and shall not be dropped vertically more than 5 feet, except where suitable equipment is provided to prevent segregation and where specifically authorized. Telephonic or other satisfactory means of rapid communication between the mixing plant and the forms in which concrete is being placed shall be provided and available for use by Government Inspectors.

2.4.2 Buckets

The interior hopper slope shall be not less than 58 degrees from the horizontal, the minimum dimension of the clear gate opening shall be at least 5 times the nominal maximum-size aggregate, and the area of the gate opening shall not be less than 2 square feet. The maximum dimension of the gate opening shall not be greater than twice the minimum dimension. The bucket gates shall be essentially grout tight when closed and may be manually, pneumatically, or hydraulically operated except that buckets larger than 2 cubic yards shall not be manually operated. The design of the bucket shall provide means for positive regulation of the amount and rate of deposit of concrete in each dumping position.

2.4.3 Transfer Hoppers

Concrete may be charged into nonagitating hoppers for transfer to other conveying devices. Transfer hoppers shall be capable of receiving concrete directly from delivery vehicles and have conical-shaped discharge features. The machine shall be equipped with a hydraulically operated gate and with a means of external vibration to effect complete and facile discharge. Concrete shall not be held in nonagitating transfer hoppers more than 30 minutes.

2.4.4 Trucks

Truck mixers operating at agitating speed or truck agitators used for transporting plant-mixed concrete shall conform to the requirements of ASTM C 94. Nonagitating equipment may be used for transporting plant-mixed concrete over a smooth road when the hauling time is less than 15 minutes. Bodies of nonagitating equipment shall be smooth, watertight, metal containers specifically designed to transport concrete, shaped with rounded corners to minimize segregation, and equipped with gates that will permit positive control of the discharge of the concrete.

2.4.5 Chutes

When concrete can be placed directly from a truck mixer, agitator, or nonagitating equipment, the chutes attached to this equipment may be used. A discharge deflector shall be used when required by the Contracting Officer. Separate chutes and other

similar equipment will not be permitted for conveying concrete except when specifically approved.

2.4.6 Belt Conveyors

Belt conveyors may be used when approved. Such conveyors shall be designed and operated to assure a uniform flow of concrete from mixer to final place of deposit without segregation of ingredients or loss of mortar and shall be provided with positive means for preventing segregation of the concrete at the transfer points and the point of placing. Belt conveyors shall be constructed such that the idler spacing shall not exceed 36 inches. If concrete is to be placed through installed horizontal or sloping reinforcing bars, the conveyor shall discharge concrete into a pipe or elephant trunk that is long enough to extend through the reinforcing bars. In no case shall concrete be discharged to free fall through the reinforcing bars.

2.4.7 Pump Placement

Concrete may be conveyed by positive displacement pump when approved. The pumping equipment shall be piston or squeeze pressure type. The pipeline shall be rigid steel pipe or heavy-duty flexible hose. The inside diameter of the pipe shall be at least 3 times the nominal maximum-size coarse aggregate in the concrete mixture to be pumped but not less than 4 inches. The maximum-size coarse aggregate shall not be reduced to accommodate the pumps. The distance to be pumped shall not exceed limits recommended by the pump manufacturer. The concrete shall be supplied to the concrete pump continuously. When pumping is completed, concrete remaining in the pipeline shall be ejected without contamination of concrete in place. After each operation, equipment shall be thoroughly cleaned, and flushing water shall be wasted outside of the forms.

PART 3 EXECUTION

3.1 PREPARATION FOR PLACING

3.1.1 Embedded Items

Before placement of concrete, care shall be taken to determine that all embedded items are firmly and securely fastened in place as indicated on the drawings, or required. Embedded items shall be free of oil and other foreign matter such as loose coatings or rust, paint, and scale. The embedding of wood in concrete will be permitted only when specifically authorized or directed. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable materials to prevent the entry of concrete into voids.

3.1.2 Concrete on Earth Foundations

Earth surfaces upon which concrete is to be placed shall be clean, damp, and free from standing or running water. Prior to placement of concrete, the earth foundation shall have been satisfactorily compacted in accordance with the provisions of SECTION: FILLS AND SUBGRADE PREPARATION. Additionally, the foundation shall be inspected by the Contractor prior to concrete placement in order to certify that it is ready to receive concrete. The results of each inspection shall be submitted in writing.

3.1.3 Construction Joint Treatment

3.1.3.1 General

Concrete surfaces to which other concrete is to be bonded shall be prepared for receiving the next lift or adjacent concrete by cleaning with either airwater cutting, sandblasting, high-pressure water jet, or other approved method. The entire surface of the existing concrete shall be cleaned to a depth of not less than 1/4 inch and to such additional depth where necessary to expose a sound unweathered concrete surface that is not contaminated by oils or other foreign matter.

3.1.3.2 Cleaning

3.1.3.2.1 Air-Water Cutting

Air-water cutting of a construction joint shall be performed at the proper time and only on horizontal construction joints. The surface shall be cut with an airwater jet to remove all laitance and to expose clean, sound, fine aggregate, but not so as to undercut the edges of the larger particles of aggregate. The air pressure used in the jet shall be 100 pounds per square inch plus or minus 10 pounds per square inch, and the water pressure shall be just sufficient to bring the water into effective influence of the air pressure. After cutting, the surface shall be washed and rinsed as long as there is any trace of cloudiness of the wash water. The surface shall again be washed just prior to placing the succeeding lift. Where necessary to remove accumulated laitance, coatings, stains, debris, and other foreign material, sandblasting will be required as the last operation before placing the next lift.

3.1.3.2.2 High-Pressure Water Jet

A stream of water under a pressure of not less than 3,000 pounds per square inch may be used for cleaning. Its use shall be delayed until the concrete is sufficiently hard so that only the surface skin or mortar is removed and there is no undercutting of coarse-aggregate particles. Where the cleaning occurs more than 2 days prior to placing the next lift or where work in the area subsequent to the cleaning causes dirt or debris to be deposited on the surface, the surface shall be cleaned again as the last operation prior to placing the next lift. If the water jet is incapable of a satisfactory cleaning, the surface shall be cleaned by sandblasting.

3.1.3.2.3 Sandblasting

When employed in the preparation of construction joints, sandblasting shall be performed as the final operation completed before placing the following lift. The operation shall be continued until all accumulated laitance, coatings, stains, debris, and other foreign materials are removed. The surface of the concrete shall then be washed thoroughly to remove all loose materials. The surface shall again be washed just prior to placing the succeeding lift.

3.1.3.2.4 Waste Disposal

The method used in disposing of waste water employed in cutting, washing, and rinsing of concrete surfaces shall be such that the waste water does not stain, discolor, or affect exposed surfaces of the structures, or damage the environment of the project area. The method of disposal shall be subject to approval.

3.1.3.2.5 Surface Condition

The surface of the lift shall be damp at the time of placement of the next lift and shall be free of standing water.

3.1.4 Removal of Existing Concrete

3.1.4.1 Sawcutting and Removal of Concrete

Concrete shall be sawcut to the true line and to the depth shown on the drawings where new concrete is to be tied into and placed with existing concrete. Existing concrete adjacent to the sawcut join line shall be removed by means of mechanical rotary abraders, chipping hammers, or by other methods as approved to expose a sound, unweathered concrete surface. The Contractor shall take all necessary precautions and shall use such methods of pavement breaking and removal as to prevent cracking, spalling, or other damage to the concrete to remain in place. Any concrete beyond the join line that is cracked, spalled, or otherwise damaged shall be removed and replaced without additional cost to the Government. Existing reinforcing steel shall be left in its original position or cut and removed where designated.

3.1.4.2 Sandblasting

3.1.4.2.1 General

Sandblasting shall be limited to only areas which new concrete is to be placed during the same 24-hour period. Any prepared surface not overlaid within this time period, shall be completely sandblasted just prior to placement of concrete. The Contractor shall remove all unsound concrete, surface debris, and residue resulting from sandblasting prior to concrete placement.

3.1.4.2.2 Sandblasting Equipment

Sandblasting equipment shall include an air compressor, hose, and venturi-type nozzles of sufficient capacity to furnish air at a rate of not less than 150 cfm and to maintain a line pressure of not less than 90 psi at the nozzle while in use. The compressor shall be equipped with traps that maintain the compressed air free of oil.

3.2 PLACING

3.2.1 General

Concrete placement will not be permitted when, in the opinion of the Contracting Officer, weather conditions prevent proper placement and consolidation. Concrete shall be deposited as close as possible to its final position in the forms and, in so depositing, there shall be no vertical drop greater than 5 feet except where suitable equipment is provided to prevent segregation and where specifically authorized. Depositing of the concrete shall be so regulated that it may be effectively consolidated in horizontal layers 1-1/2 feet or less in thickness with a minimum of lateral movement. The amount deposited in each location shall be that which can be readily and thoroughly consolidated. The surfaces of construction joints shall be kept continuously wet for the first 12 hours during the 24-hour period prior to placing concrete. Free water shall be removed prior to placement of concrete. Sufficient placing capacity shall be provided so that concrete placement can be kept plastic and free of cold joints while concrete is being placed.

3.2.2 Time Interval Between Mixing and Placing

Concrete shall be placed within 30 minutes after discharge into non-agitating equipment. When concrete is truck mixed or when a truck mixer or agitator is used for transporting concrete mixed by a concrete plant mixer, the concrete shall be delivered to the site of the work, and discharge shall be completed within 1 1/2 hours after introduction of the cement to the aggregates. When the length of haul makes it impossible to deliver truck-mixed concrete within these time limits, batching of cement and a portion of the mixing water shall be delayed until the truck mixer is at or near the construction site.

3.2.3 Cold-Weather Placing

Concrete shall not be placed without a procedure approved in accordance with paragraph: Cold-Weather Requirements when the concrete is likely to be subjected to freezing temperatures before the expiration of the curing period. The ambient temperature of the space adjacent to the concrete placement and surfaces to receive concrete shall be above 32 degrees F. The placing temperature of the concrete having a minimum dimension less than 12 inches shall be between 55 and 75 degrees F. The placing temperature of the concrete having a minimum dimension greater than 12 inches shall be between 50 and 70 degrees F. Heating of the mixing water or aggregates will be required to regulate the concrete-placing temperatures. Materials entering the mixer shall be free from ice, snow, or frozen lumps. Salt, chemicals, or other materials shall not be mixed with the concrete to prevent freezing, except that an approved chemical accelerator may be used.

3.2.4 Hot-Weather Placing

Concrete shall be properly placed and finished with approved submittal procedures in accordance with paragraph: Hot-Weather Requirements. The concrete placing temperature shall not exceed 90 degrees F. Cooling of the mixing water and/or aggregates will be required to obtain an adequate placing temperature. An approved retarder may be used to facilitate placing and finishing. Steel forms and reinforcement shall be cooled prior to concrete placement when steel temperatures are greater than 120 degrees F. Conveying and placing equipment shall be cooled if necessary to maintain proper concrete placing temperature.

3.2.5 Consolidation

Immediately after placing, each layer of concrete shall be consolidated by internal vibrating equipment. Vibrators will not be used to transport concrete within the forms. Hand spading may be required if necessary with internal vibrating along formed surfaces permanently exposed to view. Form or surface vibrators shall not be used. Spare vibrators shall be kept on site during all concrete placement operations. Consolidation will proceed independently of all other placing operations. Vibrators for consolidation will not be attached to Bidwell Type or any other screeding or leveling equipment selected by the Contractor.

<u>Application</u>	<u>Head Diameter inches</u>	<u>Frequency VPM</u>	<u>Amplitude inches</u>
Thin walls, beams, etc.	1-1/4 - 2-1/2	9,000 - 13,500	0.02 - 0.04
General construction	2 - 3-1/2	8,000 - 12,000	0.025 - 0.05

The frequency and amplitude shall be within the range indicated in the table above as determined in accordance with paragraph: Vibrators. The vibrator shall be inserted vertically at uniform spacing over the entire area of placement. The distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator. The vibrator shall penetrate rapidly to the bottom of the layer and at least 6 inches into the preceding layer if such exists. It shall be held stationary until the concrete is consolidated and then withdrawn slowly.

3.3 FINISHING

3.3.1 Unformed Surfaces

3.3.1.1 General

The ambient temperature of spaces adjacent to surfaces being finished shall be not less than 50 degrees F. In hot weather when the rate of evaporation of surface moisture, as determined by use of Figure 2.1.5 of ACI 305R, may reasonably be expected to exceed 0.2 pound per square foot per hour, provisions for windbreaks, shading, fog spraying, or wet covering with a light-colored material shall be made in advance of placement, and such protective measures shall be taken as quickly as finishing operations will allow. All unformed surfaces that are not to be covered by additional concrete or backfill shall have a float finish, unless a trowel finish is specified, and shall be true to the elevation shown on the drawings. Surfaces to receive additional concrete or backfill shall be brought to the elevation shown on the drawings and left true and regular. Exterior surfaces shall be sloped for drainage unless otherwise shown on the drawing or as directed. Joints shall be carefully made with a jointing or edging tool. The finished surfaces shall be protected from stains or abrasions.

3.3.1.2 Float Finish

A float finish shall be applied to the top of buried reinforced structures. Surfaces shall be screeded and darried or bullfloated to bring the surface to the required finish level with no coarse aggregate visible. No water, cement, or mortar shall be added to the surface during the finishing operation. The concrete, while still green but sufficiently hardened to bear a man's weight without deep imprint, shall be

floated to a true and even plane. Floating may be performed by use of suitable hand floats or power-driven equipment. Hand floats shall be made of magnesium or aluminum. Tolerance for a floated finish shall be true plane within 5/16 inch in 10 feet as determined by a 10-foot straightedge placed anywhere on the slab in any direction.

3.3.1.3 Trowel Finish

A trowel finish shall be applied to the following surfaces: top of channel walls, street gutters, and as indicated on the drawings. Concrete surfaces shall be finished with a float finish, and after surface moisture has disappeared, the surface shall be troweled to a smooth, even, dense finish free from blemishes including trowel marks. Tolerance shall be true planes within 5/16 inch in 10 feet as determined by a 10-foot straightedge placed anywhere on the slab in any direction.

3.3.1.4 Broom Finish

A broom finish shall be applied to the following surfaces: concrete channel inverts and channel side slopes. The concrete shall be screeded and floated to required finish plane with no coarse aggregate visible. After surface moisture disappears, but before curing is applied, the surface shall be broomed or brushed with a fine hair-broom or fiber bristle brush in a direction transverse to that of the main traffic or as directed.

3.3.2 Formed Surfaces

After form removal, all fins and loose materials shall be removed. All voids and honeycombs exceeding 1/2 inch in diameter and all tierod holes permanently exposed to view shall be reamed or chipped and filled with drypack mortar. Defective areas larger than 36 square inches in any surface, permanently exposed or not, shall be delineated in a rectangular shape by a saw cut a minimum depth of one inch. All defective concrete in the delineated area shall be removed and replaced with carefully placed and compacted concrete. The cement used in the mortar or concrete for all surfaces permanently exposed to view shall be a blend of Portland cement and white cement properly proportioned so that the final color when cured will be the same as adjacent concrete. Temperature of the concrete, ambient air, replacement concrete, or mortar during remedial work including curing shall be above 50 degrees F. The prepared area shall be dampened, brush-coated with a neat cement grout or with an approved epoxy resin, and filled with mortar or concrete. The mortar shall consist of 1 part cement to 2-1/2 parts fine aggregate. The quantity of mixing water shall be the minimum necessary to obtain a uniform mixture and to permit placing.

Mortar shall be thoroughly compacted in place and struck off to adjacent concrete. Replacement concrete shall be drier than the usual mixture and thoroughly tamped into place and finished. Forms shall be used if required. Metal tools shall not be used to finish permanently exposed surfaces. The patched areas shall be cured for 7 days.

3.4 CURING AND PROTECTION

3.4.1 General

All concrete shall be cured by an approved method for a period of 7 days. Immediately after placement, concrete shall be protected from premature drying, extremes in temperatures, rapid temperature change, and mechanical injury. All materials and equipment needed for adequate curing and protection shall be available and at the placement site prior to the start of concrete placement. Concrete shall be protected from the damaging effects of rain for 12 hours and from flowing water for 14 days. Concrete shall be shielded from direct rays of the sun for 3 days. No fire or excessive heat shall be permitted near or in direct contact with concrete at any time.

3.4.2 Moist Curing

Concrete moist-cured shall be maintained continuously (not periodically) wet for the entire curing period. If water or curing materials stain or discolor concrete surfaces that are to be permanently exposed, they shall be cleaned as required in paragraph: Appearance. Where wooden form sheathing is left in place during curing, the sheathing shall be kept wet at all times. Horizontal surfaces may be moist cured by ponding, by covering with a minimum uniform thickness of 2 inches of continuously saturated sand, or by covering with saturated nonstaining burlap or cotton mats. Horizontal construction joints may be allowed to dry for 12 hours immediately prior to the placing of the following lift.

3.4.3 Membrane Curing

Concrete may be cured with an approved curing compound in lieu of moist curing except that membrane curing will not be permitted on any surface to which other concrete is to be bonded or on any surface containing protruding steel reinforcement. All surfaces shall be cured with pigmented-type curing compound conforming to paragraph CURING MATERIALS subparagraph Membrane-Forming Curing Compound.

3.4.3.1 DELETED

3.4.3.2 Application

The curing compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. The surfaces shall be thoroughly moistened with water, and the curing compound applied as soon as free water disappears. The curing compound shall be applied to unformed surfaces as soon as free water has disappeared. The curing compound shall be applied in a twecoat continuous operation by approved motorized powerspraying equipment operating at a minimum pressure of 75 pounds per square inch, at a uniform coverage of not more than 400 square feet per gallon for each coat, and the second coat shall be applied perpendicular to the first coat. When adverse breeze conditions occur, Contractor shall take the necessary precautions to prevent the curing compound from becoming airborne. These precautions shall include, but not limited to, lowering the spray nozzle to approximately 2 feet away from the concrete surface and erecting wind breaks. The method used shall be submitted to the Contracting Officer for approval.

Concrete surfaces that have been subjected to rainfall within 3 hours after curing compound has been applied shall be resprayed by the method and at the coverage herein specified. All concrete surfaces on which the curing compound has been applied shall be adequately protected for the duration of the entire curing period from pedestrian and vehicular traffic and from any other cause that will disrupt the continuity of the curing membrane.

3.4.4 Impervious-Sheet Curing

The concrete invert surfaces may be cured by an approved impervious sheet. All surfaces shall be thoroughly wetted and be completely covered with waterproof paper, polyethylene film, or polyethylene-coated burlap having the burlap thoroughly water-saturated before placing. Covering shall be laid with lightcolored side up. Covering shall be lapped not less than 12 inches and securely weighted down or shall be lapped not less than 4 inches and taped to form a continuous cover with completely closed joints. The sheet shall be weighted to prevent displacement so that it remains in contact with the concrete during the specified length of curing. Coverings shall be folded down over exposed edges of slabs and secured by approved means. Sheets shall be immediately repaired or replaced if tears or holes appear during the curing period.

3.4.5 Cold Weather

When the daily outdoor low temperature is less than 32degrees F, the temperature of the concrete shall be maintained above 40 degrees F for the first 7days after placing. In addition, during the period of protection removal, the air temperature adjacent to the concrete surfaces shall be controlled so that concrete near the

surface will not be subjected to a temperature differential of more than 25 degreesF as determined by observation of ambient and concrete temperatures indicated by suitable thermometers installed adjacent to the concrete surface and 2 inches inside the surface of the concrete. The installation of the thermometers shall be made by the Contractor at such locations as may be directed. Curing compounds shall not be used on concrete surfaces that are maintained at curing temperature by use of free steam.

3.4.6 Nonshrink Grout Application

Nonshrink grout shall conform to the requirements of paragraph NONSHRINK GROUT. Water content shall be the minimum that will provide a flowable mixture and fill the space to be grouted without segregation, bleeding, or reduction of strength. Mixing and placing shall be in conformance with the material manufacturer's instructions and as specified. Grout shall not be retempered or subjected to vibration from any source.

3.5 CONTRACTOR QUALITY CONTROL

3.5.1 General

The Contractor shall perform the inspection and tests described in paragraph: Inspection Details and Frequency of Testing, and based upon the results of these inspections and tests, he shall take the action required in paragraph: Action Required and submit reports as required in paragraphs: Action Required and Reports. The laboratory performing the tests shall conform with ASTM C 1077. The individuals who sample and test concrete or the constituents of concrete as required in this specification shall have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to the ACI minimum guidelines for certification of Concrete Field Testing Technicians, Grade I.

3.5.2 Inspection Details and Frequency of Testing

3.5.2.1 Fine Aggregate

3.5.2.1.1 Grading

At least once during each shift in which concrete is being delivered, there shall be one sieve analysis and fineness modulus determination in accordance with ASTM C 136 and COE CRD-C 104, respectively, for the fine aggregate or for each fine aggregate, if it is batched in more than one size or classification. The location at which samples are taken may be selected by the Contractor as the most advantageous for control. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits. Results of tests shall be reported in writing.

3.5.2.1.2 Moisture Content

When in the opinion of the Contracting Officer the electric moisture meter is not operating satisfactorily, there shall be at least four tests for moisture content in accordance with either ASTM C 70, C 566, or COE CRD-C 112 during each 8-hour period of mixing plant operation. The times for the tests shall be selected randomly within the 8-hour period. An additional test shall be made whenever the slump is shown to be out of control or excessive variation in workability is reported by the placing foreman. When the electric moisture meter is operating satisfactorily, at least two direct measurements of moisture content shall be made per week to check the calibration of the meter.

3.5.2.2 Coarse Aggregate

3.5.2.2.1 Grading

At least once during each shift that concrete is being delivered, there shall be a sieve analysis in accordance with ASTM C 136 for each size group of coarse aggregate.

The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. However, the Contractor is responsible for delivering the aggregate to the mixer within specification limits. A test record of samples of aggregate taken shall show the results of the five most recent tests including the current test. The Contractor may adopt limits for control coarser than the specification limits for samples taken other than at the batch plant bins to allow for degradation during handling. Results of tests shall be reported in writing.

3.5.2.2.2 Moisture Content

A test for moisture content of each size of coarse aggregate in accordance with ASTM C 566 or COE CRD-C 112 shall be made at least once a shift. When two consecutive readings for smallest size coarse aggregate differ by more than 0.5 percent, frequency of testing shall be increased to that specified for fine aggregate in paragraph: Moisture Content. These results shall be used to adjust the added water in the control of the batch plant.

3.5.2.3 Deleterious Substances

When in the opinion of the Contracting Officer a problem exists in connection with deleterious substances in fine or coarse aggregates, tests shall be made in accordance with ASTM C 33 at a frequency not less than one per week. Results of tests shall be reported in writing.

3.5.2.4 Scales

3.5.2.4.1 Weighing Accuracy

The accuracy of the scales shall be checked by test weights at least once a month for conformance with the applicable requirement of paragraph: Scales. Such tests shall also be made whenever there are variations in properties of the fresh concrete that could result from batching errors. Results of tests shall be reported in writing.

3.5.2.4.2 Batching and Recording Accuracy

Once a week the accuracy of each batching and recording device shall be checked during a weighing operation by noting and recording the required weight, recorded weight, and the actual weight batched. The Contractor shall provide the necessary calibration devices and confirm that the admixture dispensers described in paragraph: Equipment are operating properly. Results of tests shall be reported in writing.

3.5.2.5 Batch-Plant Control

The measurement of all constituent materials including cement, pozzolan, each size of aggregate, water, and admixtures shall be continuously controlled. The aggregate weights and amount of added water shall be adjusted as necessary to compensate for free moisture in the aggregates. The amount of air-entraining admixture shall be adjusted to control air content within specified limits. A report shall be prepared indicating type and source of cement used, type and source of pozzolan used, amount and source of admixtures used, aggregate source, the required aggregate and water weights per cubic yard, amount of water as free moisture in each size of aggregate, and the batched aggregate and water weights per cubic yard for each class of concrete batched during plant operation. The report shall be submitted to the Contracting Officer.

3.5.2.6 Concrete

3.5.2.6.1 Air Content

At least two tests for air content shall be made on randomly selected batches of each class of concrete during each 8-hour period of concrete production. Additional tests shall be made when excessive variation in workability is reported by the

placing foreman or the Contracting Officer. Tests shall be made in accordance with ASTM C 231. For concrete having a nominal maximum aggregate size of 3/4 to 1-1/2 inches, the average of each set of two tests shall be plotted on a control chart on which the average is set at 5 percent and the upper and lower control limits at 4 and 6 percent, respectively. The control charts shall be submitted to the Contracting Officer.

3.5.2.6.2 Slump

At least two slump tests shall be made on randomly selected batches of each mixture of concrete during each day's concrete production in accordance with ASTM C 143. Additional tests shall be made when excessive variation in workability is reported by the placing foreman or the Contracting Officer. The average of each set of two tests shall be plotted on a control chart on which the upper and lower limits are set 1.5 inches above and below the mid-range value. The range shall be plotted on a control chart on which the upper control limit is 3.0 inches. The control chart shall be submitted to the Contracting Officer.

3.5.2.6.3 Batch Tickets

The manufacturer of the concrete shall furnish to the Contracting Officer's Representative with each batch of concrete, before unloading at the site, a delivery ticket prepared in accordance with the requirements of ASTM C 94.

3.5.2.7 Preparation for Placing

Foundation or construction joints, forms, and embedded items shall be inspected in sufficient time prior to each concrete placement by the Contractor in order to certify to the Contracting Officer that they are ready to receive concrete. The results of each inspection shall be reported in writing.

3.5.2.8 Placing

The placing foreman shall supervise all placing operations, shall determine that the correct quality of concrete or grout is placed in each location as directed by the Contracting Officer, and shall be responsible for measuring and recording concrete temperatures, ambient temperature, weather conditions, time of placement, yardage placed, and method of placement. A report shall be submitted in writing to the Contracting Officer.

3.5.2.9 Vibrators

The frequency and amplitude of each vibrator shall be determined in accordance with COE CRD-C 521 prior to initial use and at least once a month when concrete is being placed. Additional tests shall be made when a vibrator does not appear to be adequately consolidating the concrete. The frequency shall be determined while the vibrator is operating in concrete with the tachometer being held against the upper end of the vibrator while almost submerged and just before the vibrator is withdrawn from the concrete. The amplitude shall be determined with the head vibrating in air.

Two measurements shall be taken, one near the tip and another near the upper end of the vibrator head, and these results averaged. The make, model, type, and size of the vibrator and frequency and amplitude results shall be reported in writing.

3.5.2.10 Curing

3.5.2.10.1 Moist Curing

At least once each day during the curing period, an inspection shall be made of all areas subject to moist curing. The surface moisture condition shall be reported in writing.

3.5.2.10.2 Curing Compound

No curing compound shall be applied until it has been verified that the compound is properly mixed and ready for spraying. At the end of each operation, the quantity of compound used and the area of concrete surface covered shall be reported, and the rate of coverage in square feet per gallon shall be computed. The report shall state whether coverage is uniform.

3.5.2.10.3 Impervious-Sheet Curing

At least once each day during the curing period, an inspection shall be made of all areas being cured using impervious sheets. The condition of the covering and the tightness of the laps and tapes shall be noted and recorded.

3.5.2.11 Protection

At least once a day during the curing period, an inspection shall be made of all areas subject to cold-weather protection. Deficiencies shall be noted. During removal of protection, measurement of concrete and ambient temperature shall be made at least hourly. A report shall be submitted in writing to the Contracting Officer.

3.5.2.12 Mixer Uniformity

3.5.2.12.1 Concrete Plant Mixer

At the start of concrete placing, and at least once every 3 months when concrete is being placed, uniformity of concrete shall be determined. The tests shall be performed in accordance with ASTM C 94. Whenever adjustments in mixer or increased mixing times are necessary because of failure of any mixer to comply, the mixer shall be retested after adjustment. Results of tests shall be reported in writing.

3.5.2.12.2 Truck Mixers

At the start of concrete placing and at least once every 6 months when concrete is being placed, uniformity of concrete shall be determined in accordance with ASTM C 94. The truck mixers shall be selected randomly for testing. When satisfactory performance is found in one truck mixer, the performance of mixers of substantially the same design and condition of blades may be regarded as satisfactory. Results of tests shall be reported in writing.

3.5.2.13 Action Required

3.5.2.13.1 Fine Aggregate

3.5.2.13.1.1 Grading

When the amount passing any sieve is outside the specification limits, the fine aggregate shall be immediately resampled and retested. If there is another failure on any sieve, the fact shall immediately be reported to the Contracting Officer, and immediate steps shall be taken to rectify the situation.

3.5.2.13.1.2 Moisture

Whenever the moisture content of the fine aggregate changes by 0.5 percent or more, the scale settings for the fine-aggregate batcher and water batcher shall be adjusted directly or by means of a moisture compensation device.

3.5.2.13.2 Coarse Aggregate Grading

When the amount passing any sieve is outside the specification limits, the coarse aggregate shall immediately be resampled and retested. If the second sample fails on any sieve, that fact shall be reported to the Contracting Officer. Where two consecutive averages of five tests are outside specification limits, that fact shall

be reported to the Contracting Officer, and immediate steps shall be taken to correct the grading.

3.5.2.13.3 Deleterious Substances

When the results for a deleterious substance are outside the specification limit, the aggregate shall be resampled and retested for the deleterious substance that failed.

If the second sample fails, that fact shall be reported to the Contracting Officer.

When material finer than No. 200 sieve for coarse aggregate exceeds the specification limit, immediate steps, such as washing or other corrective actions, shall be initiated.

3.5.2.13.4 Scales

Whenever either the weighing accuracy or batching accuracy is found not to comply with specification requirements, the plant shall not be operated until necessary adjustments or repairs have been made. Discrepancies in recording accuracies shall be corrected immediately.

3.5.2.13.5 Concrete

3.5.2.13.5.1 Air Content

Whenever points on the control chart approach the upper or lower control limits, an adjustment should be made in the amount of air-entraining admixture batched. If a single test result is outside the specification limit, such adjustment is mandatory.

As soon as practical after each adjustment, another test shall be made to verify the correctness of the adjustment. Whenever a point falls above the upper control limit for range, the dispenser shall be calibrated to ensure that it is operating correctly and with good reproducibility. Whenever two consecutive points for either average or range are outside the control limits, the Contracting Officer shall be notified. Whenever the air content departs from the specified range, the concrete shall not be delivered to the forms.

3.5.2.13.5.2 Slump

Whenever points on the control chart approach the upper or lower control limits, an adjustment should be made in the batch weights of water and fine aggregate. The adjustments are to be made so that the total free water does not exceed that amount specified in the approved mixture proportions based on the free water available with the fine aggregate and that amount of water batched. If the adjustments to the batch weights or water and fine aggregate do not satisfactorily produce the required slump, the mixture shall be reportioned to meet the specified criteria and resubmitted to the Contracting Officer for approval. When a single slump is outside the control limits, such adjustment is mandatory. As soon as practical after each adjustment, another test shall be made to verify the correctness of the adjustment. Whenever the slump exceeds the upper limit stipulated in paragraph: Mixture Proportioning, subparagraph Slump, the concrete shall not be delivered to the forms. Whenever two consecutive slump tests, made during a period when there was no adjustment of batch weights, produce a point on the control chart for range above the upper control limit, the slump shall be considered to be out of control, and the additional testing for aggregate moisture content required in paragraph: Inspection Details and Frequency of Testing shall be undertaken.

3.5.2.13.6 Placing

The placing foreman shall not permit placing to begin until he has verified that an adequate number of acceptable vibrators in working order and with competent operators are available. Placing shall not be continued if any pile of concrete is inadequately consolidated. If any batch of concrete fails to meet the temperature requirements, immediate steps shall be taken to improve temperature controls.

3.5.2.13.7 Curing

3.5.2.13.7.1 Moist Curing

When a daily inspection report lists an area of inadequate curing, the required curing period for that area shall be extended by 1 day.

3.5.2.13.7.2 Curing Compound

When the coverage rate of curing compound is less than that specified or when the coverage is not uniform, the entire surface shall be sprayed again.

3.5.2.13.7.3 Impervious-Sheet Curing

When a daily inspection report lists any tears, holes, or laps of joints that are not completely closed, the tears and holes shall promptly be repaired or the sheets replaced, the joints closed, and the required curing period for those areas shall be extended by 1 day.

3.5.2.13.8 Protection

When any concrete temperature during the period of protection or protection removal fails to comply with the specifications, that fact shall be reported to the Contracting Officer, and immediate steps should be taken to correct the situation.

3.5.2.13.9 Mixer Uniformity

When a mixer fails to meet mixer uniformity requirements, either the mixing time shall be increased or adjustments shall be made to the mixer until compliance is achieved.

3.5.2.14 Reports

All results of tests or inspections conducted shall be reported informally as they are completed and as required. A weekly report shall be prepared for the updating of control charts covering the entire period from the start of the construction season through the current week. All reports generated from tests obtained in the field shall include features of work, stationing, and other pertinent information, as directed by the Contracting Officer. During periods of cold weather protection, reports of pertinent temperatures shall be made daily. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Such reports of failures and the action taken shall be confirmed in writing in the routine reports. The Contracting Officer has the right to examine all Contractor quality control test and inspection records.

-- End of Section --